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TECHNICAL EVALUATION OF DOSIMETER CORPORATION OF  
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AND ENVIRONMENTAL HEALTH LAB BROOKS AF. J A CALDWELL

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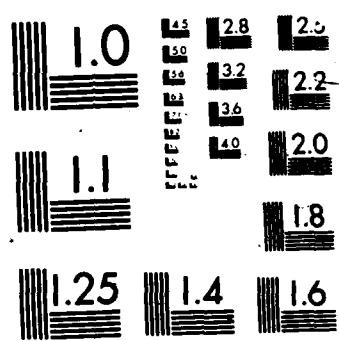
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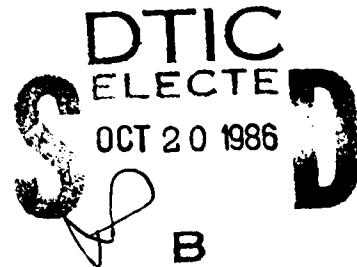
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**TECHNICAL EVALUATION OF DOSIMETER CORPORATION  
OF AMERICA MODEL 005 POCKET DOSIMETER  
USAFOEHL, BROOKS AFB TX**

**JOHN A. CALDWELL, II, TSGT, USAF**

**August 1986**

**Final Report**



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**USAF Occupational and Environmental Health Laboratory  
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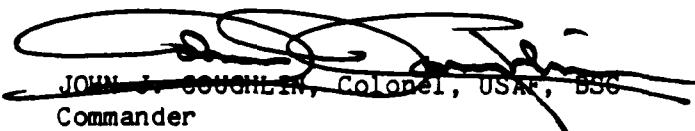
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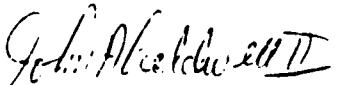
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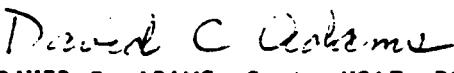
This report has been reviewed and is approved for publication.

  
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A technical evaluation of the DCA Model 005 Pocket Dosimeter was accomplished on 18-19 Jun and 1 Jul 86 at Kelly and Brooks AFB to access the variability caused by temperature and humidity extremes. Discrepancies were identified and considerations recommended.			
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**I. BACKGROUND:** As requested by San Antonio Air Logistics Center (SA-ALC), a technical evaluation of the Dosimeter Corporation of America (DCA) model 005 pocket dosimeter was accomplished to (1) determine variability with changes in temperature and humidity, and (2) verify the response capability of the dosimeters rejected by PMELs and returned to SA-ALC. On 18-19 Jun and 1 Jul 86 USAFOEHL personnel performed the evaluation at Kelly AFB and Brooks AFB TX.

**II. SURVEY PERSONNEL** TSgt John A. Caldwell, II

**III. PERSONS CONTACTED**

Capt Michael Stroup	Project Engineer, NDI Equipment	925-6961
1Lt Gary Schultz	Project Engineer, Radiation Detection Equipment	925-6961
Mr Luciano Guerra	Equipment Specialist, Radiation Detection Equipment	925-8635

**IV. TEMPERATURE AND HUMIDITY PROCEDURE**

A. A Sperry 160 kVp x-ray tube, model SPX-160, was used to irradiate the dosimeters in an environmentally controlled chamber.

B. The dosimeters were evaluated under two environmental extremes; 100°F/100% RH, and 20°F/20%RH. Both conditions were accomplished at ambient barometric pressure.

C. The dose rate from the x-ray unit was determined with the MDH Model 1015, OEHL No. 1883, Serial No. 1615, calibrated 24 Jan 86 with an MDH Mammography probe, Model 10X5-6M, Serial No. 7087.

D. The x-ray beam was attenuated using 2.5 mm of aluminum to reduce the dose rate of the x-ray unit to acceptable levels. The dose rate was 0.505 R/min at 1 meter.

E. The dosimeters were subjected to an integrated exposure of 250 mR with the x-ray unit operating at 80 kVp, 1.7 mA exposure.

F. The dosimeters were centered in the beampath of the unit and allowed to stabilize in the chamber for 15 minutes prior to the first exposure.

G. The dosimeters to be evaluated were separated into three groups; New, Repackaged, and Returned. Five dosimeters from each group were selected at random for the evaluation.

H. All indicated exposures in Tables 1 and 2 were the average of three consecutive exposures.

I. All readings were multiplied by an Air Density Correction Factor (ADCF) to increase the accuracy. The ADCF was calculated as follows:

$$\frac{273.15 + \text{TEMP}}{295.15} \times \frac{760}{\text{BP}}$$

Where: TEMP = Temperature in degrees Celsius  
BP = Barometric Pressure in mm Hg

## V. TEMPERATURE AND HUMIDITY METHODOLOGY

- A. All exposures were made in free air.
- B. All dosimeters were zeroed, exposed and read in the vertical position.
- C. The MDH x-ray monitor was used to determine exposure time required for an integrated exposure of 250 mR. The correction factor is the number by which the readings on the dosimeter should be multiplied to get the actual exposure which the dosimeter (and the user) received.
- D. The indicated exposure is the dose reading from the dosimeter.
- E. The correction factor was obtained as follows:

$$\text{Correction Factor} = (\text{Actual Exposure}) / (\text{Indicated Exposure})$$

## VI. TEMPERATURE AND HUMIDITY RESULTS AND CONCLUSIONS

The data indicate that the response of the model 005 Pocket Dosimeter to x-ray radiation is approximately 6% to 50% low depending on the environmental conditions. Consideration should be given to generating an Air Density Correction Factor (ADCF) for each base location according to their particular environmental factors at the time or by the season. This would help compensate for the wide variability of the dosimeter readings. Note that ADCF calculations are not required by T.O. 33K7-2-1-1.

## VII. RESPONSE CAPABILITY PROCEDURE

- A. The evaluation of the returned D-005 dosimeters was accomplished IAW T.O. 33K7-2-1-1. There were two deviations from the T.O.; all measurements indicated in Tables 3 and 4 are the average of three consecutive exposures, and ADCF was applied to increase the accuracy.
- B. Twenty (59%) of the original 34 dosimeters satisfied leak test criteria and were used in the evaluation. The 14 dosimeters that were not evaluated were rejected for quality control acceptance reasons; namely, hair-lines that could not be located.

**VIII. RESPONSE CAPABILITY RESULTS AND CONSIDERATIONS:**

A. As determined by the data in Tables 3 and 4 and IAW T.O. 33K7-2-1-1, the acceptance level would increase from 60% to 75% by the application of the ADCF to each dosimeter correction factor.

B. The reason for the return of the 13 acceptable dosimeters to SA-ALC/MMIRAC is unknown.

C. If there are any questions concerning this report, please contact TSgt Caldwell, AV 240-2613, Comm 536-2613.

TABLE 1

## Response of the DCA Model 005 Pocket Dosimeter to X-Ray

18 Jun 86

PARAMETERS: 80 kVp, 1.7 mA, 2.5 mm Al Total Filtration  
 0.505 R/min Dose Rate  
 Actual Dose: 250 mR, Exposure Time: 30 sec.

CALIBRATION STANDARD: MDH Model 1015, OEHL No. 1883, SN 1615  
 Used with the Mammography Probe Model 10X5-6M,  
 SN 7087

ENVIRONMENTAL CONDITIONS: Temperature: 100°F, Relative Humidity: 100%  
 Barometric Pressure: 741.9 mm Hg  
 ADCF: 1.079

	DOSIMETER SN	INDICATED EXPOSURE (mR)	CF W/O ADCF	CF W/ ADCF
GROUP I				
	50051	240	1.042	1.124
	50054	225	1.111	1.199
	50100	235	1.064	1.148
	60190	230	1.087	1.165
	60198	243	1.028	1.109
GROUP II				
	10006	240	1.042	1.124
	10019	255	0.980	1.057
	10033	243	1.029	1.110
	10062	233	1.073	1.158
	10074	236	1.059	1.143
GROUP III				
	60209	325	0.769	0.829
	60234 *	-	-	-
	80327	166	1.506	1.625
	80340 *	-	-	-
	80346	246	1.016	1.096

Each value listed is average of three exposures

Average Correction Factor W/O ADCF = 1.067

+ 7.8% Difference

Average Correction Factor W/ADCF = 1.145

\* These dosimeters failed because the hairlines were not visible at the beginning of the exposure procedure nor throughout two or more exposures.

TABLE 2

## Response of the DCA Model 005 Pocket Dosimeter to X-Ray

19 Jun 86

PARAMETERS: 80 kVp, 1.7 mA, 2.5 mm Aluminum Total Filtration  
 0.505 mR/min Dose Rate  
 Actual Dose: 250 mR, Exposure Time: 30 sec.

CALIBRATION STANDARDS: MDH Model 1015, OEHL No. 1883, SN 1615  
 Used with the Mammography Probe Model 10X5-6M, SN 7087

ENVIRONMENTAL CONDITIONS: Temperature: 20°F, Relative Humidity: 20%  
 Barometric Pressure: 741.9 mm Hg  
 ADCF: 0.971

	DOSIMETER SN	INDICATED EXPOSURE (mR)	CF W/O ADCF	CF W/ ADCF
GROUP I				
	50051	175	1.429	1.388
	50054	192	1.302	1.264
	50100	188	1.339	1.300
	60190	183	1.366	1.326
	60198	168	1.488	1.445
GROUP II				
	10006	180	1.389	1.349
	10019	205	1.219	1.184
	10033	215	1.163	1.129
	10062	180	1.389	1.349
	10074	233	1.073	1.042
GROUP III				
	60209	208	1.202	1.167
	60234 *	-	-	-
	80327	76	3.289	3.194
	80340 *	-	-	-
	80346	233	1.073	1.042

Each value listed is the average of three exposures

Average Correction Factor W/O ADCF = 1.494

- 9.6% Difference

Average Correction Factor W/ADCF = 1.398

\* These dosimeters failed because hairlines were not visible at the beginning of the exposure procedure nor throughout two or more exposures.

TABLE 3

## Response of the DCA Model 005 Pocket Dosimeter to Cs-137

For 100 mR Exposure, 1 July 86

PARAMETERS: 130 Ci Cs-137 J.L. Shepperd Model 81-10 Irradiator  
 Dose Rate: 9.9 R/Hr @ 2 meters  
 Exposure Time: 100 mR = 0.606 minutes

CALIBRATION STANDARD: Performed by Manufacturer on 20 Mar 86 using an MDH Model 2025, SN 2127, with a 3 cc probe, SN 4126, Traceable to the National Bureau of Standards

ENVIRONMENTAL CONDITIONS: Temperature: 24°C, Barometric Pressure: 745.4 mmHg  
 ADCF: 1.026

DOSIMETER SN	REASON FOR RETURN*	INDICATED EXPOSURE (mR)	CF W/O ADCF	CF W/ ADCF
30031	NHL	93	1.07	1.098
30423	OT	125	0.80	0.821
30437	OT	112	0.90	0.923
50021	OT	120	0.83	0.852
50075	MDR	123	0.81	0.831
60117	MDR	122	0.82	0.841
60201	NHL	120	0.83	0.852
60208	NHL	122	0.82	0.841
60209	OT	123	0.81	0.831
60245	UNK	117	0.86	0.882
80307	NHL	113	0.88	0.903
80315	NHL	117	0.86	0.882
80326	NHL	118	0.85	0.872
80327	NHL	118	0.85	0.872
80339	NHL	117	0.86	0.882
80342	NHL	100	1.00	1.026
80343	NHL	108	0.92	0.944
80346	NHL	108	0.92	0.944
80390	OT	120	0.83	0.852
80437	NHL	112	0.90	0.923

\*Reasons for Return by PMELs:

NHL = No Hair Line

OT = Out of Tolerance

MDR = Maintenance Deficiency Report

UNK = Unknown Discrepancy

Average Correction Factor without ADCF = 0.871

+2.26% Difference

Average Correction Factor with ADCF = 0.894

TABLE 4

## Response of the DCA Model 005 Pocket Dosimeter to Cs-137

For 400 mR Exposure, 1 July 86

PARAMETERS: 130 Ci Cs-137 J.L. Shepperd Model 81-10 Irradiator  
 Dose Rate = 9.9 R/Hr @ 2 meters  
 Exposure Time: 400 mR = 2.424 minutes

CALIBRATION STANDARD: Performed by Manufacturer on 20 Mar 86 using an MDH Model 2025, SN 2127, with a 3 cc probe, SN 4126, Traceable to the National Bureau of Standards

ENVIRONMENTAL CONDITIONS: Temperature: 24°C, Barometric Pressure: 745.4 mmHg, ADCF: 1.026

<u>DOSIMETER SERIAL No.</u>	<u>REASON FOR RETURN*</u>	<u>400mR AVE</u>	<u>CF W/O ADCF</u>	<u>CF W/ ADCF</u>
30031	NHL	362	1.11	1.139
30423	OT	478	0.84	0.862
30437	OT	480	0.83	0.852
50021	OT	482	0.83	0.852
50075	MDR	477	0.84	0.862
60117	MDR	495	0.81	0.831
60201	NHL	463	0.86	0.882
60208	NHL	475	0.84	0.862
60209	OT	488	0.82	0.841
60245	UNK	472	0.85	0.872
80307	NHL	447	0.90	0.923
80315	NHL	445	0.90	0.923
80326	NHL	450	0.89	0.913
80327	NHL	473	0.85	0.872
80339	NHL	463	0.86	0.882
80342	NHL	425	0.94	0.964
80343	NHL	447	0.90	0.923
80346	NHL	437	0.92	0.944
80390	OT	472	0.85	0.872
80437	NHL	440	0.91	0.934

\*Reasons for Return from PMELs:

NHL = No Hair Line  
 OT = Out of Tolerance  
 MDR = Maintenance Deficiency Report  
 UNK = Unknown Discrepancy

Average Correction Factor without ADCF = 0.878

+2.2% Difference

Average Correction Factor with ADCF = 0.900

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